FINAL

ENVIRONMENTAL ASSESSMENT

GENETIC RESTORATION OF THE FLORIDA PANTHER

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TABLE OF CONTENTS*

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I. OVERVIEW

The Florida panther, *Felis concolor coryi*, is one of the most endangered large mammals in the world. A small population in southwest Florida estimated to number 30-50 adults represents the only known remaining wild population of an animal that historically ranged throughout most of the southeastern United States - from Arkansas and Louisiana eastward across Mississippi, Alabama, Georgia, Florida and parts of South Carolina and Tennessee.

Geographic isolation of the taxon, habitat loss, population decline and associated inbreeding have resulted in significant loss of genetic variability and health of the population. Natural gene exchange which historically occurred between the Florida panther and other contiguous subspecies of *Felis concolor* ceased to occur when the panther became geographically fragmented from other populations of its species.

Gene flow occurs as individuals disperse among populations and breed. As dispersal is the natural mechanism for gene exchange and maintenance of genetic health within populations, those same dispersing breeders minimize the occurrence of inbreeding within populations. Inbreeding accelerates when dispersing breeders can no longer emigrate into small, isolated populations, resulting in genetic depression, declining health, reduced survivability, low numbers, and eventual extinction.

The above scenario is recognized as part of the extinction process. It is this biological circumstance that perhaps most affects the health and survivability of the Florida panther as a population.

While other human related factors affect the health of the panther's environment, it is now clear that genetic variability and health of the Florida panther must be restored for the taxon to survive even with adequate habitat preservation and other enhancement measures. Genetic restoration of the Florida panther is possible and feasible, because its historic source of genetic variability, from which it is now isolated, still exists abundantly throughout much of western North America.

II. INTRODUCTION

The Florida panther's existence is severely threatened by both rapid and gradual extinction processes. Factors of concern include habitat loss and fragmentation, environmental contaminants, prey availability, human related disturbance and mortality, disease, and genetic erosion.

Population viability analysis projections indicate that under existing demographic and genetic conditions the Florida panther will likely be extinct in only a few decades (24-63 years, Seal et al. 1992). Actual time to extinction could be accelerated significantly by the occurrence of a catastrophic population reducing event.

Extinction of the Florida panther can be avoided only if actions to enhance existing genetic conditions, along with programs to expand the sole remaining wild population (numbers and distribution), are implemented and are successful.

Programs to expand the population must include actions to preserve remaining habitats considered essential to meeting the needs of a self-sustaining population in south Florida and actions to reestablish populations and preserve habitats elsewhere within the panther's historic range. Measures to enhance genetic conditions must include actions to preserve existing genetic resources, restore diversity and viability, and manage for inbreeding problems. Consideration must be given to strategies designed to restore historic gene flow.

III. PURPOSE OF AND NEED FOR ACTION

A. <u>Purpose</u> - The purpose of the proposed action is to implement a genetic restoration and management program that is designed to improve the genetic health, survivability and recovery potential of the endangered Florida panther (*Felis concolor coryi*). The proposed program involves a strategy designed to restore lost historic gene flow into the panther from another *F.c.* subspecies. Under the proposed action, genetic restoration would be carried out directly in the sole remaining wild population, which is located in southern Florida.

It should be clearly understood that the intent of the proposed action (translocating a limited number of non-Florida individuals into the population) is to improve genetic conditions and population health of the Florida panther. It is not an action to merely "<u>add numbers</u>" to the population. The intent is that future offspring will be healthier and thus provide security against extinction initially, and ultimately provide enhanced opportunities to achieve other key recovery tasks, such as population reestablishments. Though population reestablishments are critical to recovery of the panther, they are not a part of the proposed action.

B. **Need** - Extinction of the Florida panther can be avoided only if programs to enhance existing genetic conditions and expand the sole remaining wild population (expand numbers and distribution), are implemented and are successful.

A lack of suitable, unoccupied habitat (for subadult dispersal)(Maehr 1990a) within the range of the present radio-instrumented segment of the wild population would be expected to prevent significant population growth in southwest Florida (area south of the Caloosahatchee River). However, landscapes deemed capable of supporting panthers remain within other areas formerly occupied by the Florida panther, and programs are presently underway to identify and evaluate potential population reestablishment sites range-wide and to develop technologies needed to successfully expand the existing wild population (reintroduction experiments).

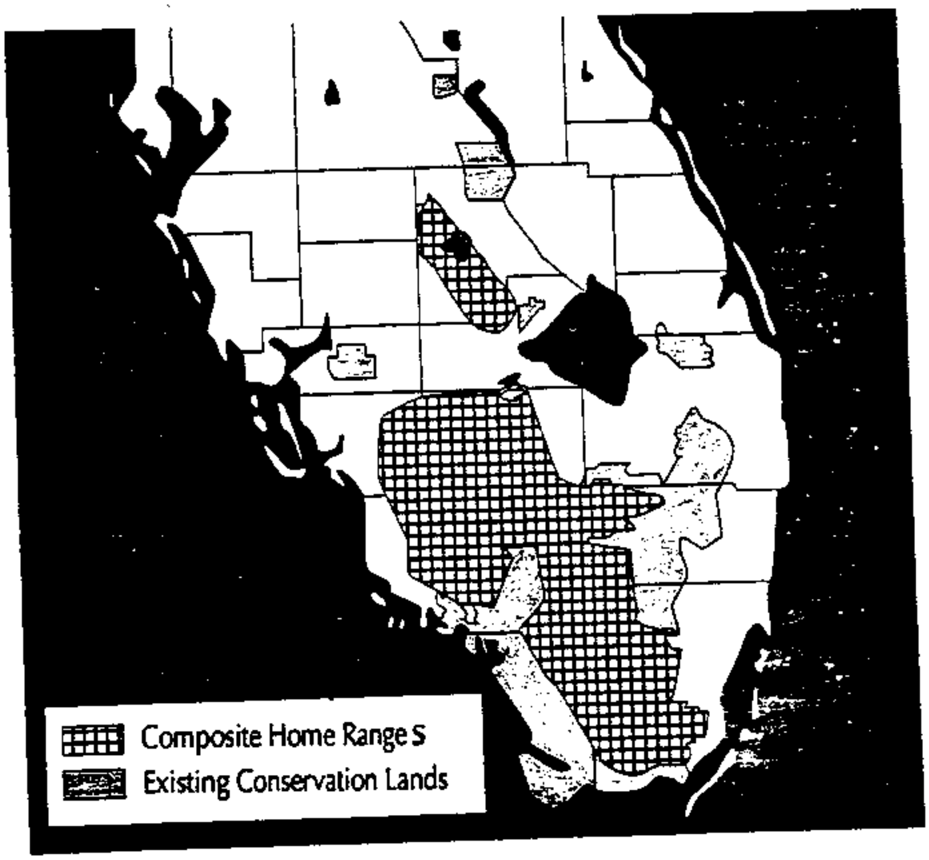
The program proposed herein is designed specifically to address the need to enhance existing genetic conditions in the Florida panther. Enhanced genetic conditions would be expected to not only improve the overall health and fitness of the Florida panther, but would be expected to result in improvements in the high incidence of maladaptive traits which include reproductive and medical abnormalities. These conditions include high levels of sperm abnormality, high incidence of cryptorchidism, and congenital heart defects. Details on these conditions are provided below.

IV. EXISTING CONDITIONS

A. **Population Size** - The sole known remaining extant population, which is located in southern Florida, is estimated to number 30 to 50 adult panthers. Because suitable habitat in south Florida is limited, this population can not be expected to achieve significant population growth via natural dispersal processes. The radio-instrumented segment of this population ($n = 16$) is presently comprised of 9 females and 7 males (November 1, 1994). The captive population is presently comprised of 5 males and 4 females.

B. **Location** - The present radio-instrumented segment of the wild population is centered around Collier and Hendry Counties in southwest Florida. Radio-instrumented panthers have also utilized habitats in Broward, Dade, Glades, Highlands, Lee, Monroe, and Palm Beach Counties (Figure 1). A total of 56 panthers have been radio-instrumented since 1982. All but one of these individuals occupied landscapes south of the Caloosahatchee River.

Figure 1. Area used by 43 radio-instrumented Florida panthers, 1981-1991.



Source: Florida Panther Habitat Preservation Plan - South Florida Population (Logan et al. 1993).

C. **Habitat** - Panthers utilize large forested tracts comprised of mixed swamp forest, cypress swamp, sawgrass marshes, mesic hammocks, sand pine scrub, and pine flatwoods (Maehr 1990b). Panthers prefer uplands, especially hardwood hammocks and pine flatwoods, over wetland forest cover (Maehr 1990a). Maehr (1990b) reports that there are approximately 2.2 million acres of occupied panther range in south Florida and that approximately half of the known breeding distribution was comprised of landscapes under private ownership. Maehr (1990a) also reports that, based on telemetry data, there is a lack of unoccupied, suitable habitat for subadult dispersal. This suggests that available landscapes south of the Caloosahatchee River are at or near carrying capacity under existing habitat conditions.

D. **Population Health** (as may be related to genetic conditions) - The Florida panther population exhibits multiple physiological abnormalities that are likely a consequence of recent close inbreeding. This inbreeding has resulted in a high incidence of maladaptive traits which include reproductive and medical abnormalities. Furthermore, the Florida panther has suffered from numerous health problems and infectious diseases that may be a consequence of a defective immune system. Population viability analysis projections indicate that under existing demographic and genetic conditions the Florida panther will likely be extinct in only a few decades (24-63 years, Seal et al. 1992). Actual time to extinction could be accelerated significantly by the occurrence of a catastrophic population reducing event.

Lost Gene Flow - Natural gene exchange which occurred historically between *F.c. coryi* and other contiguous populations of *Felis concolor* ceased to occur when the panther became geographically isolated from other populations of the species. Gene flow occurs as individuals disperse among populations and breed. Just as dispersal is the natural mechanism for gene exchange and maintenance of genetic health within populations, those same dispersing breeders minimize the occurrence of inbreeding within populations. Inbreeding accelerates when dispersing breeders can no longer emigrate into the fragmented population, resulting in inbreeding depression, loss of genetic variation, declining health, reduced survivability, lower numbers and eventual extinction. It is this biological circumstance that most seriously affects the health and survivability of the Florida population.

Literature indicates that gene exchange between the Florida panther (*Felis concolor coryi*) and other *F. concolor* subspecies occurred from the north through *F. c. couguar*, and from the west and northwest through *F. c. stanleyana* and *F. c. hippolestes* (Young and Goldman 1946).

This natural gene flow ceased at the time the Florida panther became geographically isolated, likely a century or longer ago. Isolation and accompanying population declines and inbreeding have resulted in the loss of genetic diversity and health. Recent population viability analyses project that genetic heterozygosity is being lost at a rate of approximately 6% per generation (Seal et al. 1992). Low heterozygosity levels (0.019) indicate that the Florida panther is inbred and has lost approximately half of its genetic diversity (Roelke 1990).

Genetic Reduction - Based on results of genetic testing, as summarized below from Roelke et al. (1993), surviving Florida panthers have experienced substantial inbreeding and concomitant loss of genetic diversity in their recent history. The level of mtDNA variation in the Florida panther is the lowest reported in any similarly studied feline population, including leopards, cheetahs, and other puma subspecies. Electrophoretic results indicated that the Florida panther had less variation than any other puma subspecies and is nearly as low as the level of allozyme variation reported in the two cheetah subspecies. DNA fingerprint variation seen in the Florida panther is nearly as low as the extremely compromised genetic variation in Asiatic lions from the Gir Forest Sanctuary in India.

Genetic Health - The U.S. Fish and Wildlife Service is concerned that the overall genetic health of the Florida panther may now be at a point where the panther's continued existence is doubtful without a proactive genetic restoration program. This concern is supported by several physiological impairments displayed by the population as summarized below.

Spermatozoal Traits: Semen quality and endocrine and reproductive functions have been shown to be adversely affected in some inbred lines of several species, including mice, cats, 2 lion subspecies and cheetahs (Wildt 1994). Comparative reproductive analyses of seminal traits in five feline species, revealed that Florida panther males display some of the poorest seminal quality traits ever recorded for any felid species or subspecies (Barone et el., 1994). Total motile sperm per ejaculate in the Florida panther is 18-38 times lower than in other puma subspecies, 30-270 times lower than in other felids and 30 times lower than in the cheetah. Although cougars and other large felids tend to produce high proportions of morphologically abnormal sperm, the Florida panther has a significantly greater frequency of malformed spermatozoa (average 93.5% per ejaculate) than any other subspecies; particularly noteworthy was a 42% incidence of acrosomal defects, a trait that renders sperm deficient in fertilization potential (Barone et al., 1994). Seventy-five percent of the sperm exhibit severe deformity and are classified as having primary abnormalities (Roelke 1990). Compared to *Felis concolor* from Texas, Colorado, Latin America, and North American zoos, the Florida panther has lower testicular and semen volumes, poorer sperm progressive motility, and more morphologically abnormal sperm, including a higher incidence of acrosomal defects and abnormal mitochondrial sheaths (Barone, et al. 1994).

Cryptorchidism: Cryptorchidism is heritable and is suspected to result from a sex-limited recessive (or possible dominant) autosomal gene in several domestic species: dog, sheep, swine, and cat (Romagnoli, 1991; Burns & Fraser, 1964; Claxton & Yeates, 1972; McPhee & Buckley, 1934). Sixty-five percent of free-ranging Florida panthers of Big Cypress genetic lineage are cryptorchid (as of 6/30/94), while there has been only 1 cryptorchid male of 7 males of Everglades lineage (Dunbar, 1994). Cryptorchidism has not been observed in medical examinations of over 40 free-ranging cougars captured in Texas, Colorado, British Columbia, or Chile, and was observed in only two of more than 50 captive males, one in Chile and one in a US zoo (Roelke et al., 1993). Circulating testosterone concentrations were lower in male Florida panthers with only one descended testicle than in those with two, whereas testosterone levels in Florida panthers with two normally descended testicles were no different from males in other cougar populations (Barone et el., 1994). In addition, cryptorchid male Florida panthers tend to produce fewer motile sperm per ejaculate than normal males: 0.54×10^6 compared with 2.19×10^6 (Barone et al., 1994). A high incidence of cryptorchidism in the population has been observed in the last two decades, a period in which there have been a number of documented matings between close relatives (Roelke et al., 1993). These observations document the rapid rise toward genetic fixation of a maladaptive genetic trait in a small population that continues to inbreed.

Cryptorchidism had not been reported previously in non-domestic cats of any species (Roelke et al. 1993). Cryptorchidism is believed to be a manifestation of inbreeding. In miniature Schnauzer dogs, for example, intentional inbreeding resulted in an incidence of 67% cryptorchidism (Cox et al. 1978). Until 1992, all panther males known to possess this abnormality were unilaterally cryptorchid, meaning only one testicle had not descended properly into the scrotum. This condition does not normally render the individual incapable of reproducing. However, from an overall population health and genetic standpoint it is of significant concern. This concern is magnified in the Florida panther because of the many other factors threatening panther survival. In 1992, concern over cryptorchidism heightened considerably when one of four newly captured males was determined to be bilaterally cryptorchid (neither testicle descended properly) and a second had a single, significantly smaller, partially descended testicle (Roelke and Glass 1992). Bilateral cryptorchid individuals are functionally sterile.

Congenital Heart Defects: Life threatening congenital heart defects have been observed in the population (Roelke and Glass 1992). Atrial septal defects (ASD), termed patent foramen ovale, were found in 5 out of 55 documented Florida panther mortalities from 1972 through July 1994 (Roelke et al. 1993; Dunbar, personal communication, 1994). This defect may have contributed to death in 4 out of 5 of these cases. ASD has been observed in several species including human (ASD is the most common congenital heart defect in human adults) (Braunwald 1992), but had not previously been observed in cougars and only rarely in domestic cats (Bolton & Lui 1977). The etiology of ASD is not well understood, but certain cases in humans suggest an autosomal dominant mode of inheritance (Lynch et al. 1978; Mascia and Moller 1987).

Heart murmurs occur in Florida panthers, sometimes at high frequencies (80%, compared with a frequency of occurrence of only approximately 4% with other cougar subspecies [Roelke et al. 1993]); however, the relationship between ASD and heart murmurs is not clear. Recently, hypo- and hyper-vitaminosis A have been ruled out as potential causes of cardiac abnormalities in Florida panthers (Dunbar 1994). The etiology of the cardiac defects is unknown, however, there may be a genetic explanation.

Immune Deficiencies: Additionally, some scientists now have concerns over what appears to be an inability of some, apparently "healthy" individuals, to overcome exposure to infectious agents that would normally not be expected to result in life threatening/terminal conditions; raising questions of possible <u>immune deficiencies</u> (Seal et al. 1992). The importance of population genetic diversity for loci involved in immune responses has been empirically demonstrated in several species (Roelke, et al. 1993). Through 1992, at least eight panther mortalities were attributed to infectious pathogens, although no single agent had caused widespread mortality during the study period (Roelke et al. 1993).

<u>Conclusions</u> - Based on available data, the overall genetic diversity of the panther is markedly reduced relative to other puma subspecies. In concert with these genetic measures, the population displays several physiological impairments, notably the most malformed spermatozoa of any population yet described, a recent increase in the incidence of cryptorchidism, and the abrupt appearance of a lethal congenital heart defect and heart murmurs (Roelke et al. 1993). In addition, a score of infectious pathogens has been observed to threaten the population; even in the face of an aggressive vaccination program.

__Concerns over Genetic Health__ - Concerns over genetic health of the Florida panther have surfaced on numerous occasions since the formation of the Florida Panther Interagency Committee in 1986. The subject has been the topic of three workshops specific to the issue in the recent past (May 1991, October 1992 and September 1994). Experts in the fields of genetics, small population biology, captive breeding, and panther health, biology, and demographics participating in these workshops concluded that restoration of gene flow is critical to restoring genetic health to the panther, to panther survival, and to the success of the overall recovery program. Because erosion of genetic health is continuing to occur and could rapidly accelerate at any time, conclusions at the above referenced workshops has been that a program to restore genetic health to the Florida panther must be initiated as quickly as possible.

This Environmental Assessment (EA) is intended to aid in the decision-making process regarding the development and implementation of a genetic restoration and management program. Such a program is now considered essential to the survival and recovery of the Florida panther. The purpose of this EA is to consider various courses of action that may be available for genetic restoration and management and to evaluate environmental impacts that may be associated with the implementation of these actions. It is not the intent of this assessment to provide a detailed review or accounting of other tasks that may be important to panther survival and recovery as called for in the recovery plan. The importance of other key actions, such as the protection and enhancement of the wild population and associated habitats, population reestablishment, captive breeding, etc. will not diminish with the development and implementation of a genetic management program.

E. __**Recovery Goal**__ - The present recovery objective as stated in the approved recovery plan is to achieve three viable, self-sustaining populations within the panther's historic range. Workshops in 1989 to evaluate existing population conditions and to develop a plan to achieve and maintain population viability for the panther determined that a total population of 500 breeding age animals would be needed. It was understood that because landscapes supporting panthers historically had been significantly reduced and fragmented, a total population goal of 500 breeding age animals would not likely be achievable at any __single__ population site in the wild. Therefore, the population goal of 500 would have to be achieved through the development and management of several sub-populations, both in the wild and in captivity. Minimum population goals of 50 adult panthers was established for each wild sub-population. The action proposed herein would not create any new sub-populations, but, would be expected to result in improved genetic health of the sole remaining wild population, which is located in southern Florida. Improved genetic health would provide enhanced opportunities for success of future population reestablishment programs.

F. **Recovery Thrusts** - The present Florida panther recovery program places emphases along three major thrusts: (1) actions to protect and enhance the sole remaining wild population and associated habitats; (2) actions to manage remaining genetic resources to improve genetic health; and, (3) actions to identify population reestablishment sites and develop reintroduction technologies.

G. **Genetic Restoration** - Genetic restoration can be accomplished by reinstating gene flow from western populations into the Florida population by selectively translocating individual animals that can be recruited into the population as breeders. Such a management action seeks to mimic historic gene flow into the population. The intent is not to replace, or swamp, the *F. c. coryi* gene pool with western *Felis concolor* genes. Rather, the intent is to reduce occurrence of inbreeding and restore genetic variability and vitality of offspring produced and recruited as breeders into a healthier more resilient population of *F. c. coryi*. Furthermore, the enhanced genetic variation and gene flow would provide the necessary genetic material to restore the process of natural selection to the Florida population. Thus, restoration is intended not only to reverse the consequences of inbreeding and associated loss of genetic variation, but also to restore evolutionary adaptive potential of the Florida population. Recovery of *F. c. coryi* will be greatly enhanced by such actions.

H. **Intercrossing For Genetic Restoration** - *Intercrossing*, as used herein, refers to a mating between subspecies of the same taxonomic species and simulates integradation which is a common, natural, and expected occurrence in nature wherever ranges are adjacent. The U.S. Fish and Wildlife Service (FWS) is presently developing Policy to address intercrossing and its appropriate role and application under provisions of the Endangered Species Act. The FWS has determined that genetic restoration through intercrossing can be an acceptable recovery action for the Florida panther (U.S. Fish and Wildlife Service 1994). However, as part of the intercrossing program, specific actions would have to be taken and conditions met. Significant among these are: intercrossing would have to be scientifically controlled, the genetic profile of the progeny would have to be specified and most closely resemble the listed species, the recovery plan would have to be revised to incorporate intercrossing, compliance with provisions of the National Environmental Policy Act would have to be achieved, a genetic management plan would have to be developed, and appropriate studies to ascertain whether environmental contaminants are contributing to physiological conditions observed in the population would have to be initiated.

I. **Recovery Plan Revision** - The present recovery plan for the Florida panther, which was last revised in 1987, does not have a task specific to genetic management or restoration. However, Task 1241 sets the stage for such action. Task 1241 reads: *"Fish and Wildlife Service and Florida Game and Fresh Water Fish Commission will identify biological and legal options if the genetic profile indicates low genetic diversity and subsequent detrimental effects on the population"*. To proceed with actions to address *"low genetic diversity and subsequent detrimental effects on the population"*, the following revision to the recovery plan is being undertaken (Federal Register Notice 59[177]:47149, dated September 14, 1994). A new task (Task 12411) is being added to the plan to read: *The Florida Panther Interagency Committee will develop and implement a management strategy to restore and maintain the historic genetic character of the Florida panther*.

J. **Genetic Management Plan** - A genetic management plan has been developed to guide the genetic restoration program. The plan, appended as Enclosure I to this document, describes the biological circumstances (historic and current), alternatives, implementation strategy, methods, experimental controls, monitoring, genetic and morphological objectives/profiles, source stock, and short- and long-term management needs of the proposed genetic restoration program.

K. **Environmental Contaminant Concerns** - Many physiological and reproductive abnormalities occurring in the panther population have been shown, in other species, to be caused by exposure to endocrine disrupting chemicals including mercury and some pesticides. Some of the chemicals which can cause these conditions are known to be present within the occupied range of the Florida panther (C. Facemire, USFWS, pers. comm. 1994). A summary of information on this subject to date and a proposed study design to investigate whether contaminants may cause or contribute to abnormalities which could affect recovery of the panther are presented in Enclosure II.

L. **Scoping** - Scoping to address genetic issues related to the Florida panther started as early as January 1989, with a Population Viability Analysis workshop. Other workshops were held in October 1989 (Gainesville, Florida), May 1991 (Washington D.C.), October 1992 (White Oak Conservation Center, Florida) and September 1994 (WOCC, Florida) provided opportunities to assimilate and evaluate available materials on population viability and genetics, and to develop a framework for addressing genetic management concerns for the panther. These workshops were attended by specialists in genetics, small population biology, captive breeding and captive population management, and panther health, population demographics, and biology. For the most part, information generated during these workshops provide the basis for genetic management considerations presented herein.

The purpose of the initial workshop in January 1989, was to review existing data on the Florida panther and conduct a population viability analysis. Conclusions reached during this workshop indicated that genetic variation in the Florida panther is low, reductions in fitness have already likely occurred, erosion of heterozygosity would continue without intervention, and the projected rate of erosion would be about 6 percent per generation if the population was not increased in size (Seal et al. 1989). Population modeling indicated that the Florida panther would likely go extinct within 25 to 40 years under existing genetic and demographic conditions (Seal et al. 1989).

With this projected extinction of the Florida panther, a second workshop in October 1989 was held to update the earlier viability analysis and to evaluate and consider actions that might be available and appropriate in attempting to ensure the continued existence of the Florida panther. These first two workshops resulted in the development of the Florida Panther Viability Analysis and Species Survival Plan. Because of prevailing demographic and genetic factors, it was concluded that the only reasonable prospect for survival of the panther was a strategy combining the establishment and management of a comprehensive captive breeding program, along with aggressive actions to protect and enhance the existing wild population and supporting habitats, and programs to reestablish the panther within formerly occupied areas. The program was designed with an objective of 500 breeding age panthers (captive and wild) by the year 2010 (Seal et al. 1989). Actions to develop a captive population were initiated in 1990. To date, 10 individuals have been taken from the wild as kittens for the captive population.

Stimulated by increasing concerns over a possible accelerated deterioration of genetic health in the panther and prospects that existing genetic viability may now be insufficient to ensure survival, a concept of restoring genetic fitness by simulating historic gene flow into the panther emerged. Such a program would be designed to restore genetic health that has been lost as a result of decades of isolation and inbreeding by renewing gene flow that historically occurred under natural conditions. The workshops in May 1991, October 1992 and September 1994 were held to give consideration to a program of this nature and to develop concepts, strategies and specifics for implementation.

During the 1992 workshop, nine genetic management scenarios for the panther were identified and evaluated. Details are provided in a workshop report titled: "Genetic Management Strategies and Population Viability of the Florida Panther", which is contained in this document as Enclosure III. Of the nine genetic management options evaluated in the subject report, five represent various ways to restore gene flow into the panther (options 2, 3, 4, 5, and 8). All five of these options would be expected to eventually accomplish the basic goal of restoring genetic health to the panther. Techniques utilized, levels of human involvement, support facilities and funding resources needed, and the number of animals and time intervals to achieve success would vary. Option 3 is considered the most direct, cost and time effective way to achieve improved genetic health for the wild population and is therefore, presented in this document as the proposed action (Alternative 2). Options 1, 7 and 9 are not considered viable options in terms of programs likely to be successful in significantly improving the genetic health or ensuring the continued survival of the Florida panther and are therefore not presented herein. Option 6 of the referenced report is presented as Alternative 1 in this document.

The purpose of the September 1994 workshop was to develop a Genetic Restoration and Management Plan for the Florida panther. The results of this workshop are contained in Enclosure I.

Specific to the development of this Environmental Assessment, the Florida Panther Interagency Committee, and its Technical Subcommittee reviewed and evaluated genetic information and considered potential courses of action regarding genetic management for the panther during a number of meetings. A notice of intent to prepare an Environmental Assessment addressing potential genetic management options for the Florida panther was published in the

FEDERAL REGISTER August 17, 1993. The Notice invited input from the public, affected Federal, State, and local agencies and other interested parties on the scope of options and issues that should be addressed in this Environmental Assessment. Written comments received in response to the FEDERAL REGISTER Notice, as well as those received after the close of the specified comment period will be utilized in the decision-making process, and have been incorporated, where appropriate, in this document. These comments are part of the official record.